REMARKS

Applicant respectfully requests that the foregoing amendments be made prior to examination of the present application.

Claims 1-4 are currently being amended.

Claims 5-21 are being added.

After amending the claims as set forth above, Claims 1-21 are now pending in this application, of which Claims 1, 10, 18, and 19 are independent.

Amendments to the Specification

The specification has been amended to be in a format more typical for US applications. Paragraph numbers have been added. No new matter is believed to have been added.

Amendments to the Claims

Claims 1-4 have been amended to place them in a format more typical for US applications. The amendments are believed to be supported by the specification as filed.

New Claims

Claims 5-21 have been added. Claims 5-21 are believed to be supported by the specification as filed, including by at least original claims 1-4.

Conclusion

Applicant believes that the present application is now in condition for allowance. Favorable consideration of the application as amended is respectfully requested.

The Examiner is invited to contact the undersigned by telephone if it is felt that a telephone interview would advance the prosecution of the present application.

Respectfully submitted,

Date Jan. 28, 2005 By _____

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ABSTRACT

An injector for gaseous fuel, the injector comprising a body ~~(1)~~ provided with a fuel feed duct ~~(5)~~ and with a fuel delivery duct ~~(6)~~, the fuel feed duct ~~(5)~~ and the fuel delivery duct ~~(6)~~ opening out into a chamber ~~(4)~~ of the body ~~(1)~~ in which there are mounted a valve member ~~(16)~~ and an actuator means ~~(18, 19)~~ for actuating the valve member ~~(16)~~ between a closed position and an open position in which the valve member ~~(16)~~ defines a fuel flow section, wherein the fuel delivery duct ~~(6)~~ comprises ~~including~~ a calibrated segment ~~(10)~~ of section smaller than the flow section defined by the valve member ~~(16)~~ when in the open position.

AN INJECTOR FOR GASEOUS FUEL

CROSS REFERENCE TO RELATED APPLICATIONS

This application is a National Stage of application PCT/FR03/02419, filed July 30, 2003, and claims priority to French patent application 02 09664 filed July 30, 2002, the disclosures of which are incorporated herein by reference in their entirety.

FIELD

The present invention relates to ~~an~~ a fuel injector. The fuel injector may be used with ~~for~~ gaseous fuel. The fuel injector may be suitable for use in single- or dual-carburetion engines running on liquefied petroleum gas (LPG) or the like.

In this application, the injector may serve ~~serves~~ to introduce gaseous fuel at a determined flow rate into a combustion chamber of the engine.

BACKGROUND ~~OF THE INVENTION~~

~~Such~~ Aan injector for gaseous fuel generally comprises a body provided with a fuel feed duct, and with a fuel delivery duct for delivering fuel from the injector. The fuel feed duct and the fuel delivery duct each generally has a first end opening out to the outside of the body for connection ~~respectively~~ to the fuel tank ~~or to~~ and the combustion chamber of the engine, respectively, and a second end opening out into a chamber of the body having mounted therein a valve member and means for actuating the valve member between a closed position in which the valve member is pressed against the second end of the fuel delivery duct, and an open position in which the valve member is spaced apart from the second end of the fuel delivery duct in order to define a fuel flow section. This fuel flow section is generally cylindrical in shape and of area equal to the product of the circumference of the second end of the fuel delivery duct multiplied by the distance between the second end of the fuel delivery duct and the valve member when in the open position. This distance corresponds to the

stroke of the valve member. The fuel flow section as defined in this way defines the flow rate with which fuel is delivered to the combustion chamber, and must therefore be precise since it influences the performance of the engine.

Unfortunately, the stroke of the valve member depends on the dimensions of the valve member itself and of certain components of the actuator means, and also on the clearances that exist between these various elements. The accuracy of the stroke thus depends on the quality of the machining and on the quality of the assembly of ~~said~~ the various elements, thus making manufacture of the injector difficult. In addition, the effects of temperature, shocks, vibration, ~~or more generally~~ and general wear~~,~~ all lead to changes ~~modifications~~ (which are only temporary for temperature) to the dimensions and the clearances defining the stroke, such that the fuel flow section and ~~thus also~~ the delivery flow rate do not remain constant over time. Thus, there is a need to have an injector capable of delivering fuel without unexpected variations in the delivery flow rate.

~~OBJECT OF THE INVENTION~~

~~BRIEF~~ SUMMARY ~~OF THE INVENTION~~

~~To this end, the invention provides~~ One embodiment is directed to an injector for gaseous fuel, the injector comprising a body comprising ~~provided with~~ a fuel feed duct and ~~with~~ a fuel delivery duct, the fuel feed duct and the delivery duct opening out into a chamber of the body in which there are mounted a valve member, and an actuator means for actuating the valve member between a closed position and an open position in which the valve member defines a fuel flow section, wherein the fuel delivery duct comprises ~~including~~ a calibrated segment of section smaller than the fuel flow section defined by the valve member when in the open position. ~~Thus, t~~The section of the calibrated segment determines the delivery flow rate independent~~ly~~ of the stroke of the valve member.

~~It would therefore be advantageous to have an~~This embodiment may provide an injector capable of delivering fuel without unexpected variations in flow rate.

Other characteristics and advantages of the invention appear on reading the following description of a particular and non-limiting embodiment of the invention.

BRIEF DESCRIPTION OF THE ~~FIGURES~~ DRAWINGS

Reference is made to the accompanying drawings, in which:

Figure 1 is a diagrammatic section view of an injector in accordance with one embodiment theinvention, the valve member being in its closed position; and

Figure 2 is a fragmentary diagrammatic view on a larger scale andin section of an said injector, with the valve member being in its open position.

DETAILED DESCRIPTION ~~OF THE INVENTION~~

By way of example, the injector described herein is intended for fitting to the engine of a motor vehicle.

With reference to Figure 1 and Figure 2 the figures, the injector in accordance with an embodiment the invention comprises a body given overall reference 1, comprised of a which body is implemented in the example shown in two portions, namely: a top half-body 2 and a bottom half-body 3 that are fastened to one another together.

The top half-body 2 top and the bottom half-body bodies 2 and 3 define between them a chamber given overall reference 4, into which there opens out a fuel feed duct 5 and a fuel delivery duct given overall reference 6.

The fuel feed duct 5 is formed in the bottom half-body 3 and has possesses a first one end that opens to the outside of the body 1 for connection to the fuel tank of a the motor vehicle, and a second an opposite end that opens out into the chamber 4.

The fuel delivery duct 6 is formed in an endpiece 7 mounted on the bottom half-body 3 so that the fuel delivery duct 6 has possesses an end a first end that opens to the

out outside the body 1 for connection to the combustion chamber of an the engine, and a second an opposite end that opens out via an opening 8 into the chamber 4.

The fuel delivery duct 6 has a frustoconical segment 9 extending from the opening 8 to a calibrated segment 10, tapering towards the said calibrated segment 10, followed by a terminal segment 11 which is connected to the calibrated segment 10.

The frustoconical segment 9 has possesses an angle at the apex of less than 55° at the angle of the frustoconical segment 9. The frustoconical segment 9 could have an angle of any suitable number of degrees at its apex, including, but not limited to substantially equal to 40°. A suitable number of degrees for the angle at the apex of the frustoconical segment is one that limits and which is preferably substantially equal to 40°, as shown. This value serves to limit disturbances of flow rate in this the frustoconical segment 9.

The calibrated segment 10 presents comprises a section which is designed to correspond to the delivery rate that is to be supplied by the injector. The terminal segment 11 is of section that is not less than that of the calibrated segment 10.

The fuel delivery duct 6 is also arranged to ensure that the flow speed of the fuel in the calibrated segment 10 is solid sonic. In this way, a delivery flow rate is obtained that is substantially constant in spite of variations in the pressure downstream from the calibrated segment 10.

The chamber 4 is subdivided into a top compartment 12 and a bottom compartment 13, (top and bottom relative to the orientation of the injector shown in the figures) wherein the top compartment 12 is located above the bottom compartment 13. The chamber 4 is subdivided into the top compartment 12 and the bottom compartment 13 by means of a diaphragm 14 which extends transversely to the axis of the fuel delivery duct 6 at the opening 8. The diaphragm 14 has comprises a peripheral edge 15 held captive between the top half-body 2 and the bottom half-body 3, a central portion 16 in register with the opening 8 in order to form a valve member, 16, and an intermediate portion 17 connecting the peripheral edge 15 to the central portion 16. The intermediate portion 17 is elastically deformable so that the central portion valve member 16 of the diaphragm 14 can move

between a closed position (see as illustrated in Figure 1) in which the central portion valve member 16 is pressed against the edge of the opening 8, and an open position (see as illustrated in Figure 2), in which the central portion valve number 16 is spaced apart from the edge of the opening 8, and co-operates cooperates therewith to define a cylindrical fuel flow section for the fuel. The fuel flow section can be any number of suitable shapes, including, but not limited to, cylindrical. The area of the cylindrical fuel flow section is can be equal to the product of the circumference of the opening 8 multiplied by the distance between the edge of the opening 8 and the central portion 16 of valve number in the diaphragm 14. The circumference of the opening 8 and the distance between the edge of the opening 8 and the central portion 16 of in the diaphragm 14 are can be designed so that the a cylindrical fuel flow section is greater than the section of the calibrated segment 10 so that the rate at which fuel is delivered delivery rate is determined by the section of the calibrated segment 10 and not by the cylindrical fuel flow section.

The injector has means for actuating the central portion valve member 16 of in the diaphragm 14 to move between it's the open and closed positions of the valve member. These actuator means are can be housed in the top compartment 12 of the chamber 4 and comprise a magnetic core 18 surrounded by a coil 19 associated with means 20 providing a connection with an electrical power supply 20 (not shown). It will be observed that inIn order to improve return of the central portion valve member 16 of in the diaphragm 14 to it's the closed position of the valve member 16, a fraction of the fuel taken from the fuel feed duct 5 can be delivered into the top compartment 12 in order to establish a backing pressure therein. By way of example, and not be way of limitation,

As an indication, for an opening 8 having comprised of a diameter of 8 millimeters (mm) and a diaphragm having a central portion 16 with a stroke of 0.3 mm, the calibrated segment 10 has can have a diameter of about 2 mm.

Naturally, the invention is not limited to the embodiment described and variants can be applied thereto without going beyond the ambit of the invention as defined by the claims. In particular, tThe structure of the injector may be different from that described, and for example the bottom half-body 3 and the endpiece 7 may be made as a constructed to

be a single part. The actuator means may also be different and could, for example, incorporate mechanical means for returning the valve member 16 into its closed position, e.g. a spring. For example, the mechanical means can include, but is not limited to, a spring. Furthermore, theThe numerical values mentioned are given purely by way of example.